

Reuse Assessment

Colbert Landfill, Spokane County, Washington



Introduction

Across the country, recreational use and solar energy projects have become a viable redevelopment option for closed landfills and cleanup sites, providing a beneficial reuse on properties that often have few other redevelopment opportunities. Spokane County expressed interest in understanding the future use considerations for recreational ballfields and solar energy generation on the Colbert Landfill. In response, EPA Region 10 and the EPA Superfund Redevelopment Initiative sponsored a reuse assessment for the Colbert Landfill to evaluate the site's suitability to accommodate solar power generation and recreational use. The Colbert Landfill Reuse Assessment provides an evaluation of recreational reuse and solar energy generation options for the landfill.

Site Overview

The 40-acre Colbert Landfill site is located two miles north of Colbert, Washington. The site is owned by Spokane County. From 1968 through 1986, the landfill received municipal and commercial wastes. The disposal of solvent wastes at the landfill contaminated soil and groundwater with volatile organic compounds (VOCs). After the 1987 Remedial Investigation/Feasibility Study, EPA determined that three aquifers in the landfill vicinity were contaminated and recommended a "pump and treat" remedy to address the contamination. An upgraded landfill cover was completed in 1996. Following cleanup, operation and maintenance activities are ongoing.

Reuse Considerations

The landfill is relatively flat and open and may be suitable for a solar array for both energy generation and recreational uses for residents and nearby Riverside and Mead School Districts. Any future use of the site will need to be compatible with the containment system including the need for long-term monitoring and ensuring there are no adverse impacts to the integrity of the system and cap cover.

Remedial Components

- Groundwater Extraction Systems – Ten extraction wells remove groundwater with high VOCs
- Groundwater Treatment Systems – Air stripper removes VOCs from the groundwater

- Components Associated with Landfill Post-Closure¹ – Includes a 32-acre cover that prevents interaction between waste and surficial soil, and a landfill gas system that prevents off-site gas migration and buildup of gas pressure
- Monitoring Program – Wells, influent and effluent are sampled for VOCs
- Institutional controls and alternate water supply to impacted residents – Limits are placed on what water can be used for, and households no longer draw water from contaminated aquifers

Cover System

The primary function of the site's cover is to minimize infiltration of precipitation into the waste. The site's cover system is composed of a 60-mil high density polyethylene (HDPE) liner, installed over a 6-inch prepared subgrade of native material. The HDPE is covered with an 18-inch sand layer, then a 6-inch layer of topsoil. Drought-tolerant native grasses were then planted on the cover. The 1997 O&M manual states that the grasses will be 18 to 24-inches high, and were chosen to eliminate the need for watering and mowing (p. 2-7). The site's cover was designed with a 4% grade to provide sufficient drainage while accommodating ongoing settlement of the underlying waste.¹ The O&M manual states that the site's grading and vegetation are "relied upon to prevent erosion of the cover material" (p. 2-4). The O&M manual also calls for the cover's original design conditions to be "maintained as closely as is practical, including type and depth of cover, materials, subsurface drainage, design grades, and any structures and equipment associated with the cover system" (p. 2-5).

Settlement

According to the site's 2014 Five-Year Review, there has been very little settlement of the landfill cover since 1999 (less than 0.1 feet).

Restricted Activities

Spokane County filed a restrictive covenant for the site in September 2009. The restrictive covenant restricts the following activities:

- drilling wells
- any activity that could release the site's contamination
- any activity that would threaten the landfill cap or interfere with the cleanup

The site's restrictive covenant also requires the property owner to maintain fences and locked gates around the property and perform regular inspections to assure that the restrictions on access to the property are effective.

Remedial Component Considerations

Future use of the landfill will need to ensure no adverse impacts to the integrity of the landfill system and cover, including:

- No vehicles are allowed on the cover system, as stipulated in the 1997 O&M manual.
- Any changes to the cover's original design conditions (e.g., vegetation, grading) needs to be approved by EPA and Ecology. Additional O&M may be needed to ensure that the cover continues to function as intended.

¹ Operations and Maintenance Manual for Colbert Landfill Closure, CH2MHILL, May 1997, p. 2-1. The state's regulations for landfill closure require a minimum slope of 2%.

- Monitoring wells, gas probes and other remedial features need to remain secure and tamper proof.
- Public access to the on-site landfill office and facilities are restricted.



Figure 1. Site features.

Land Use Considerations

Access and Location

The site is in Spokane County, about 2 miles north of Colbert, near Highway US-2. The site has two vehicular entrances off N. Elk Chattaroy Road. The southwest entrance is near the intersection of N. Elk Chattaroy Road and US-2 and is used most frequently as the main entrance to the landfill facility and the adjacent transfer station.

A secondary access to the northern perimeter road is used less frequently, typically on a quarterly basis to sample the monitoring wells located on the northern boundary of the site. This access road may be more suitable for public access to minimize conflict with the light industrial traffic accessing the transfer station. The drainage ditch located between the access roads and the landfill could present access challenges that could be addressed by adding additional culverted crossings.



Figure 2. Existing drainage ditch with crossing and culvert.

Surrounding Land Use

The Little Spokane River is approximately 3,000 feet to the west of the site. Mead and Riverside School Districts serve the surrounding area. The County owns parcels immediately north and west of the Site, and the North Transfer Station is situated adjacent to the Site to the west.

The area is predominantly rural and zoned “Rural Traditional” which is also consistent with the land use identified in the County’s Comprehensive Plan (see Figure 3).

- Spokane County Zoning Code²: The Rural Traditional (RT) zone includes large-lot residential uses and resource-based industries, including ranching, farming and wood lot operations. Industrial uses are limited to industries directly related to and dependent on natural resources. Rural-oriented recreation uses are also included in this zoning category. Rural residential clustering is allowed to encourage open space and resource conservation.
- The Zoning Code does not specify solar arrays as a specific use, but public utility local distribution facilities are permitted and use determinations not specifically addressed in the Zoning Code Use Matrix can be made by the Planning Director.

² Spokane County Zoning Code, 2016. <https://www.spokanecounty.org/documentcenter/view/19974>

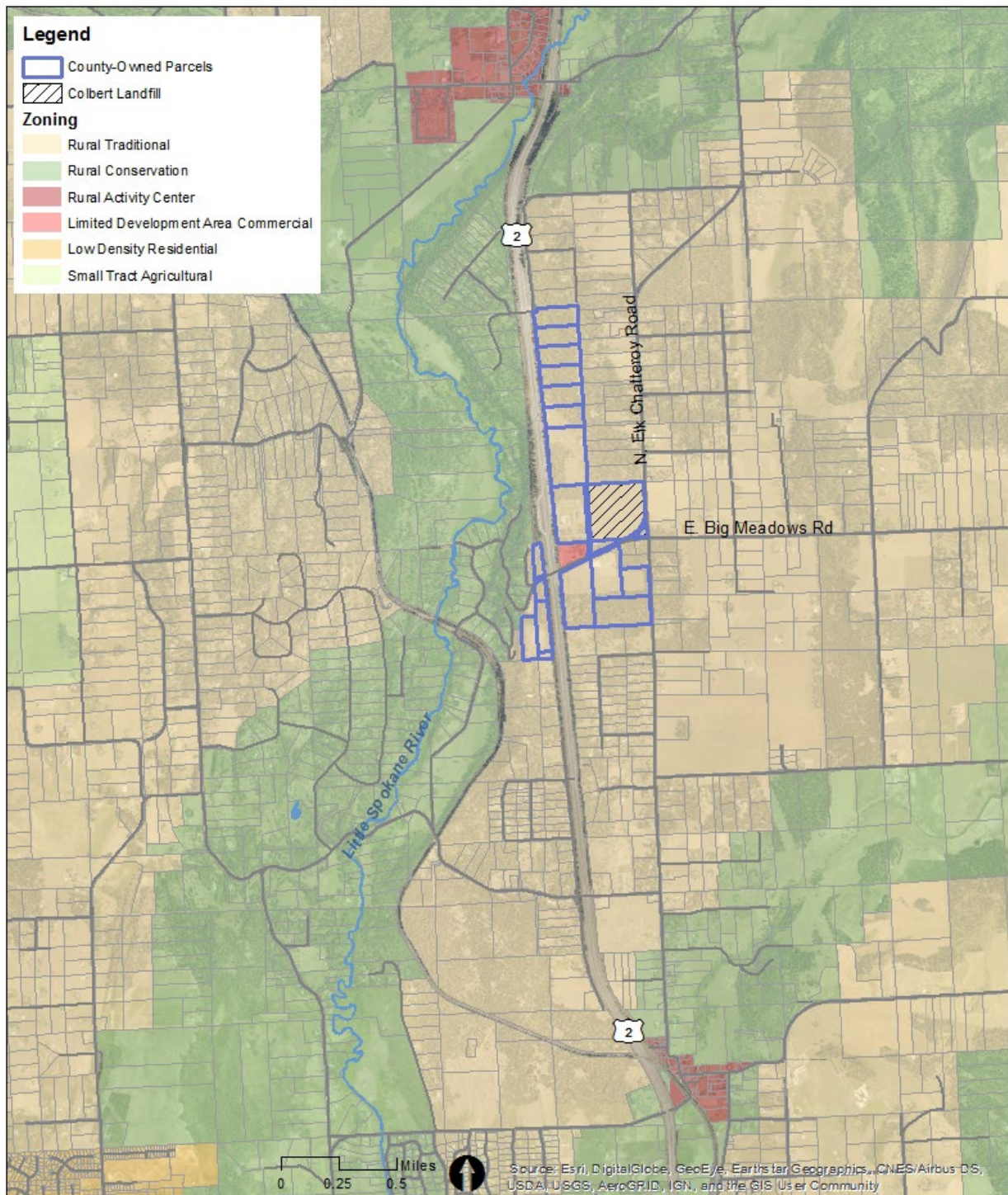


Figure 3. Existing zoning and surrounding land use, county-owned parcels are highlighted.

Slope

The as-built drawings (February 1996) show the western portion of the landfill is graded at a relatively consistent 2% slope and the eastern portion with an approximate 4% slope (see Figure 4).

Natural grass athletic fields typically have up to a 2.5 % slope from the crown in the center of the field to the sideline areas to ensure proper drainage. The preferred slope for soccer fields is 1%, but a 2% slope from the crown can provide adequate drainage.

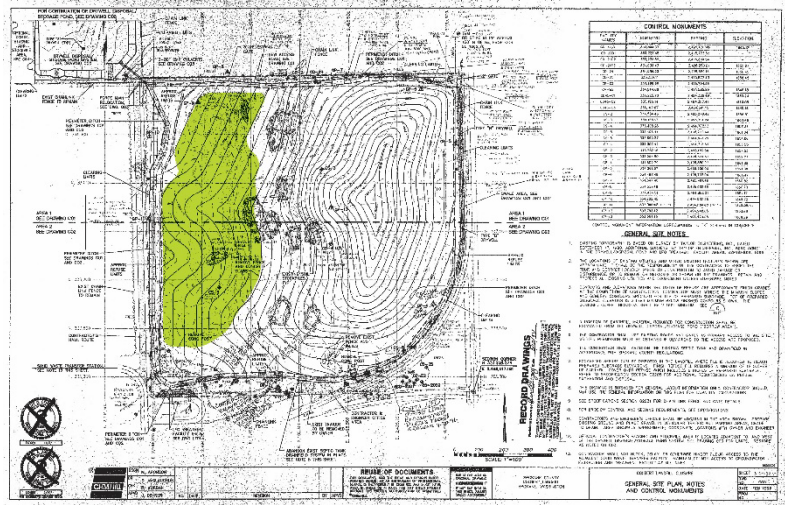


Figure 4. Area with 2% slope shown in green.

Reuse Suitability

Figure 5 below identifies potential reuse suitability zones for recreation and solar generation based on reuse considerations including remedial components, access, surrounding land use, and site features. The table on the following page provides additional detail about each reuse suitability zone.

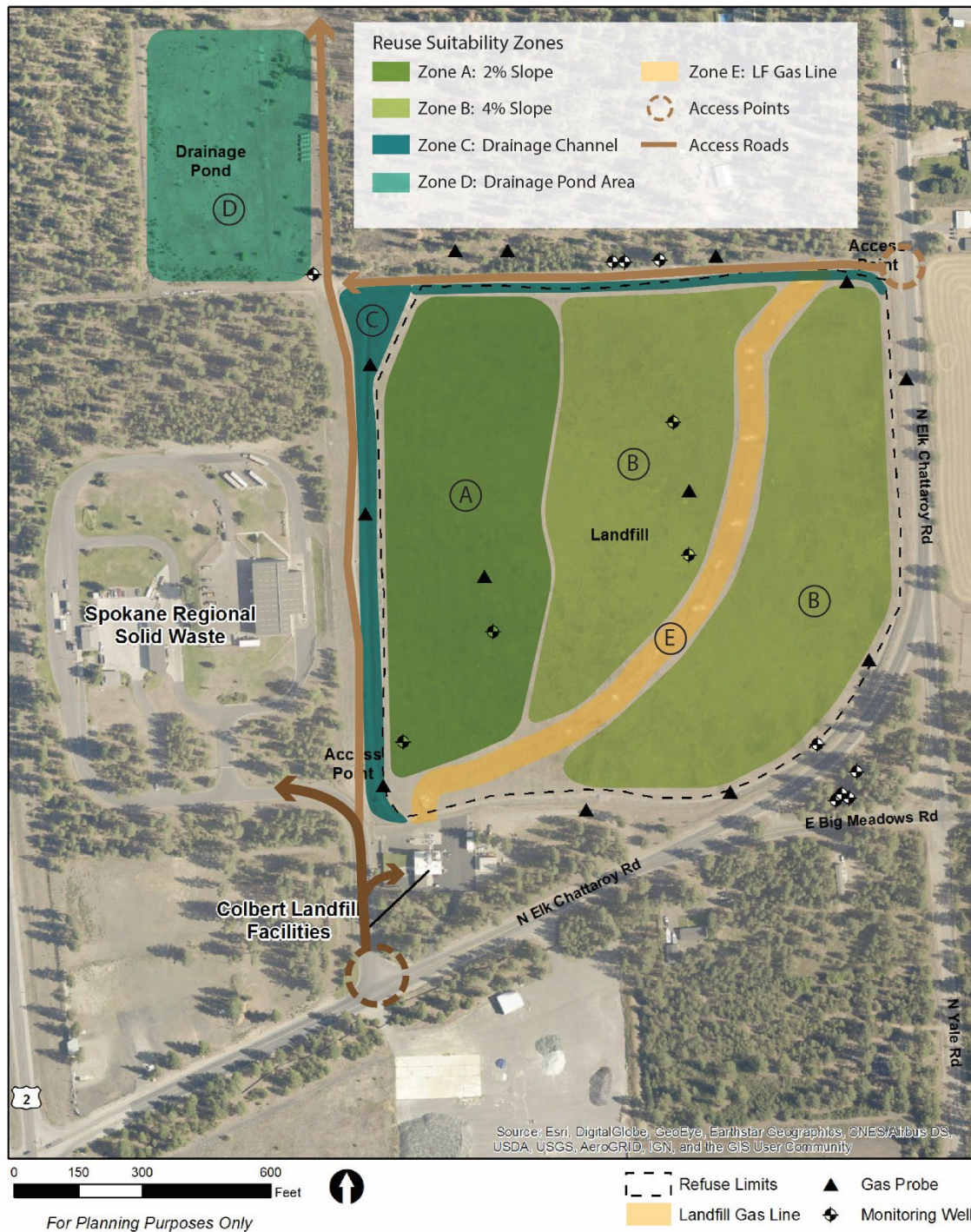


Figure 5. Reuse Suitability Zones

Reuse Zones	Description
Zone A	Areas on the landfill with an existing 2% slope. This area may best accommodate athletic fields with the least amount of grading or disturbance.
Zone B	Areas on the landfill with an existing 4% slope. To avoid grading and cap disturbance to establish athletic fields, these areas may be best suited for passive recreational uses. The eastern-most area of Zone B may be harder to access and therefore better suited for passive uses or solar panels.
Zone C	Perimeter drainage ditch with limited crossings to access landfill. Additional crossings may be needed to provide access to the landfill area.
Zone D	Underutilized drainage pond area may be suitable for other uses.
Zone E	Underground landfill gas collection line may not be suitable for athletic fields or solar uses, and access to this area may need to be limited.

Reuse Options

While the site can spatially accommodate athletic fields, the potential site improvements needed to establish proper field conditions (2% slope) and cap disturbance restrictions may make other adjacent county-owned parcels more suitable for active athletic fields. The landfill could provide other recreational amenities to complement the athletic fields, such as open space for walking and informal play. Parking would need to be provided for recreational users, however vehicular access to the landfill is currently prohibited per the O&M Manual. The restrictive covenant would also need to be revised to allow for public access.

Athletic Field Considerations

On-site or nearby parking will be needed to support athletic field use at the site. Any irrigation system for natural fields would need to be designed to work with the landfill cap to avoid impacting the liner or applying more water than the grass can absorb. Chisman Creek Park in Virginia is an example of an irrigation system installed on top of a low-permeability landfill cap to support recreational use. More information here: <https://semspub.epa.gov/work/HQ/176439.pdf>. Artificial or synthetic turf may be another field option, which could minimize the need for irrigation and potentially create less disturbance to the cap from recreational use. Any digging or cover disturbance to install light poles, electric lines, baseball backstop, field posts would need to be coordinated with EPA and Ecology.

The space requirements of athletic fields vary by field type. Figure 6 illustrates how the landfill and surrounding County-owned parcels are spatially large enough to accommodate various typical athletic fields. Fields would need to be configured to avoid the existing wells.

Solar arrays could potentially be located in Zone A or B, access may need to be restricted if public recreational use is provided in the same area to avoid tampering with the panels or damage from stray balls. The following section provides more detail on solar power considerations at Colbert Landfill.

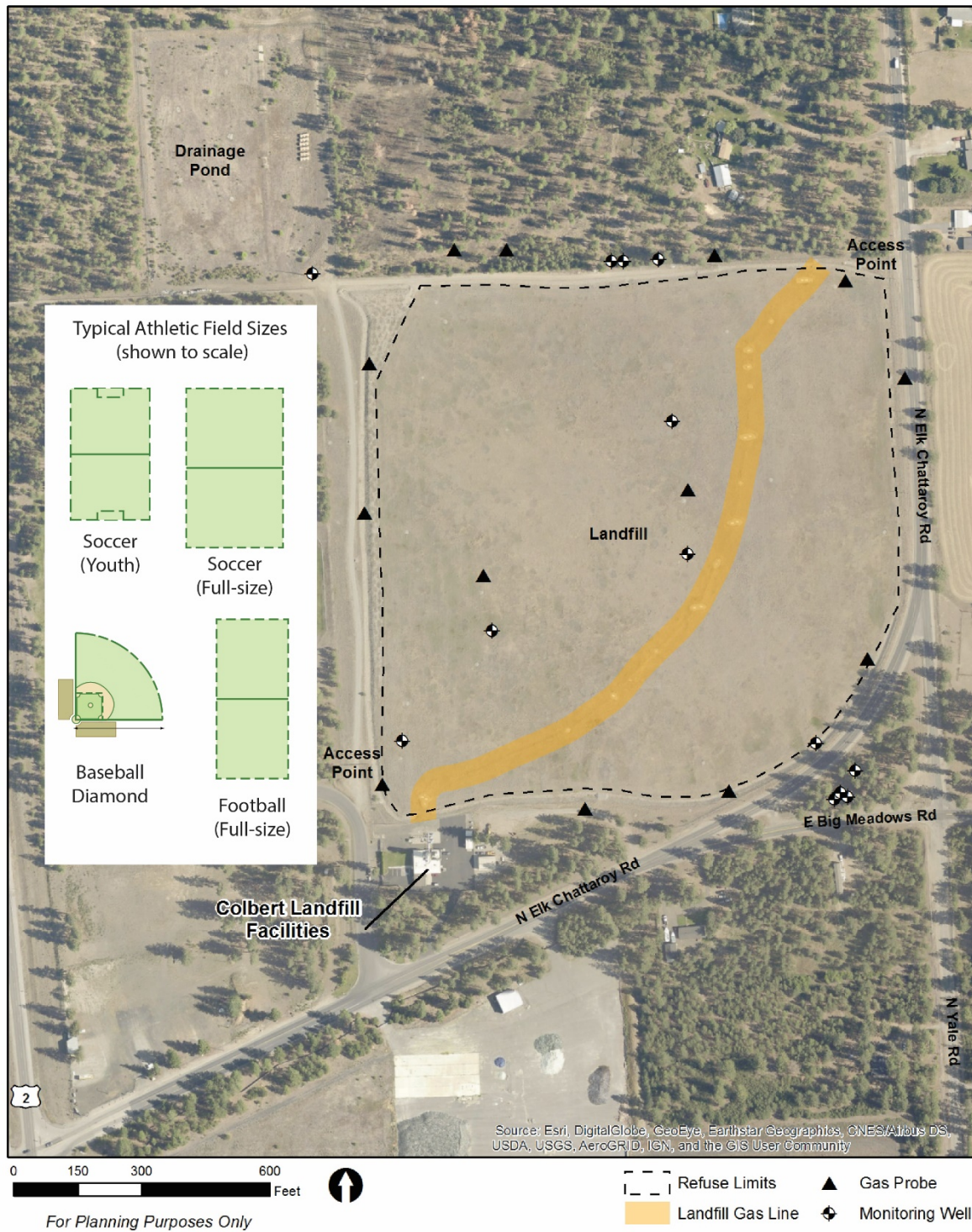


Figure 6. Diagram showing athletic field sizes.

Solar Power Considerations

Solar Resource

A site's solar resource affects a project's economic viability. The Spokane area has a solar resource of about 4 to 4.5 kWh/m²/day. Solar radiation levels of 6 kWh/m²/day are considered excellent. If suitable incentives and conditions are in place, even locations with a modest solar resource can support solar projects.

Topography

Solar systems are best suited for large unshaded areas that are either flat or with gentle south-facing slopes (less than 10% slope). Because of development restrictions often placed on landfills, solar projects can be feasible projects with the potential to generate some economic benefit on a site that might otherwise have limited redevelopment options. The topography of the Colbert Landfill is generally flat, which is well-suited for solar use.

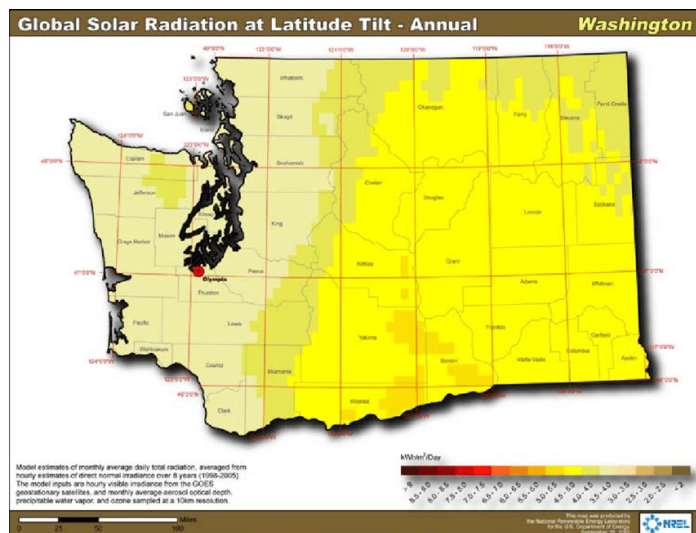


Figure 7. Solar Resource Map for Washington (Source: NREL)

Interconnection

- Electricity at the site is provided by Avista, which is being acquired by Hydro One.
- In Avista's service territory, power generating projects between 100 kW and 80,000kW (or 80 MW) can sell their power to an electric utility under the Public Utility and Regulatory Policy Act of 1978. Interconnection applications are available at <https://www.myavista.com/about-us/services-and-resources/interconnection>.
- According to the county, the closest substation is 1.5 miles away. However, this substation is owned by a different electric utility. An interconnection study would be needed to determine the best way to connect a solar project at the site to the grid.

Remedy Compatibility

Solar development is likely compatible with the existing cover, provided that the project is designed in a way that does not threaten the integrity of the remedy. In general, an area of 5-8 acres can accommodate a solar project up to 1MW in size. Any reuse should be coordinated with the site's EPA and Ecology project managers.

Precautions that must be observed to prevent damage to the site's cap and other remedy components include:

- *Load bearing capacity* – avoid loads that might punch through or strain the composite cap and liner system or cause differential settlement.
 - No vehicles or equipment are allowed on the cover system, as stated in the 1997 O&M manual (p. 2-6).

- The 1997 O&M manual states that when the soil cover needs to be removed to repair the HDPE liner, “only authorized equipment (low ground pressure tracks, no larger than a Caterpillar Model D6R LGP, having a ground pressure of not more than 4.6 psi) must be operated on the cover system” (p. 2-6).
- “Where possible, landfill access should be along the perimeter roads established around the cover” (p. 2-6).
- *Landfill cover* – maintain integrity of the landfill’s cover, which includes the liner and soil cover.
 - Vegetation on the cap is relied upon to prevent erosion of the cover material.
- *Drainage system* – maintain positive surface drainage. The cover was designed to minimize infiltration of precipitation into the waste.
- *Landfill gas control system* – Avoid damaging the site’s landfill gas management system. Take precautions when working near flammable landfill gas.
- *Construction and routine use* – consider load bearing capacity when stockpiling materials and heavy equipment use during construction, and maintain permanent access to remedial components.

Preliminary Solar System Cost

Hypothetical solar PV system size, generation and cost estimates for a potential project at the landfill are highlighted below. Estimates cover two different sized systems: a smaller system that could potentially be net metered (owner receives credit for solar energy generated) and a larger utility-scale system. Costs in the solar industry are changing rapidly and any potential project could see reduced costs in future years. In 2016, the average annual electricity consumption for a residential utility customer in Washington was 11,460 kWh, an average of 955 kWh per month³. In Spokane, a 1MW solar project could potentially generate 1,189,000 kWh (or 1,189 MWh) of electricity in a year, which is enough electricity to power approximately 104 homes. See Attachment A for the potential financial impact of a 1 MW solar array and Attachment B for more information on a small system for on-site use.

Estimated Size	Estimated Output	Installed Costs	Annual O&M Costs ⁴
100 kW	114,000 – 124,000 kWh/year	\$200K – \$300K	\$1.5K – \$2K
1 MW	1,139,000 – 1,239,000 kWh/year	\$2M – \$3M	\$15K – \$20K
Assumptions: System Costs: \$2 to \$3 per watt installed. ⁵ No incentives included. O&M Costs: \$15 to \$20 per kW per year. ⁶ Area Needed: 5 - 8 acres / MW of AC nameplate capacity (maximum potential output of system). ⁷ Output estimated using https://pvwatts.nrel.gov and address of site.			

³ https://www.eia.gov/electricity/sales_revenue_price/pdf/table5_a.pdf

⁴ O&M requirements for solar panels can include: preventive maintenance (panel cleaning, water drainage, vegetation management, upkeep of system monitoring, inspection of inverter and panels) and corrective maintenance (tightening cable connections that have loosened, replacing fuses, repairing damaged equipment, repairing mounting structures).

⁵ 2017 NREL report found costs of \$1 to \$2 per watt installed for utility-scale and commercial photovoltaic projects (<https://www.nrel.gov/news/press/2017/nrel-report-utility-scale-solar-pv-system-cost-fell-last-year.html>). This analysis assumes a cost of \$2 to \$3 per watt installed to accommodate additional costs associated with a landfill site, as well as higher costs due to tariffs imposed in 2018 on imported solar panels.

⁶ <https://www.nrel.gov/docs/fy17osti/68023.pdf>

⁷ <https://www.nrel.gov/docs/fy13osti/56290.pdf>

Ownership / Development Options

There are a range of potential ownership options for a solar project including: 1) Direct County Ownership, 2) Land Lease, 3) Third-party Ownership Lease, and 4) Community Solar (shared ownership). The current legal status for third-party solar power purchase agreements (PPAs) in Washington state is unclear.⁸ See Table 2: Project Development Scenarios for more information.

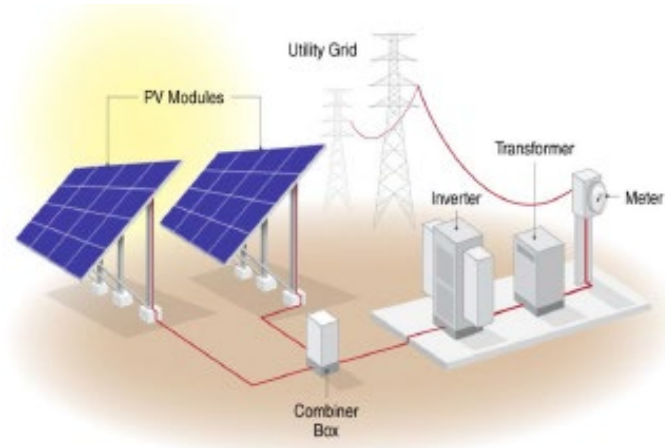


Figure 8: Solar PV ground-mounted array diagram (source: NREL)

⁸ <https://www.nrel.gov/solar/rps/wa.html>

Table 2: Project Development Scenarios

Scenario	Summary	Pros	Cons
Direct Ownership (county) ¹	A non tax-paying entity (e.g., a county) owns and operates a PV system. Project financing through general obligation bond, a stand-alone bond, bank financing, grants, municipal revenue or a combination.	<ul style="list-style-type: none"> • Potential ability to fund project through issuing bonds. • Control over project design, operation and risk. • Municipalities could potentially develop and then sell projects on their own lands. 	<ul style="list-style-type: none"> • Large-scale PV projects are capital intensive. • Municipalities “owning” a solar project cannot directly benefit from the tax-credit based incentives available to private companies. • Project management requires significant capital and infrastructure.
Land Lease	Project developer responsible for all aspects of project development and maintenance. Developer negotiates a land lease with the host municipality and sells or net meters electricity.	<ul style="list-style-type: none"> • Low cost method (to county) for getting project built • Low-risk option – payment is generally made to the site owner/host regardless of whether or how well a PV system operates. 	<ul style="list-style-type: none"> • Ongoing site access required for system O&M. • Lease payments generally made only once a purchase agreement with end user has been finalized. • Site ownership needs to be clearly defined and understood by both sides.
Third-Party Ownership Lease ²	An entity hosts and submits lease payments on the solar energy system over a period of years (or decades), rather than paying for the power produced (e.g., a Power Purchase Agreement).	<ul style="list-style-type: none"> • Leases can be structured for no/low up-front costs. • Elimination of O&M expenses and no unexpected costs. • Leases can include option to purchase system in future at fair market value. 	<ul style="list-style-type: none"> • Limited control over project design and operation. • May not be eligible for certain utility incentives if the county doesn’t own the solar system • Energy generated by the leased system can’t be sold to third parties but can be net metered. • Lengthy lease periods (15-25 years)
Community Solar (Shared Ownership)	Solar project that provides power and/or financial benefit to, or is owned by, multiple members. Can be utility owned or LLC sponsored (for profit or nonprofit).	<ul style="list-style-type: none"> • Access/opportunity to invest in solar project (e.g., low income access) • Customers may be able to take federal tax credit on their share. • Can help utilities work toward any RPS goals. 	<ul style="list-style-type: none"> • Potential legal limitations to sharing electricity output • Lack of access to federal tax incentives for non-tax paying entities. • SEC compliance can be onerous • Can come at expense of self-generation • Subscription models with utilities may reduce community control
<p>1. Although a county would not itself be able to take advantage of federal tax credits, a county may enter into an agreement with an entity that can take advantage of the tax credits.</p> <p>2. The legal status of Third Party Power Purchase Agreements (PPAs) in Washington is currently unclear, but solar developers can offer third party leases. Municipalities can also negotiate the right to purchase a solar project from a developer after federal incentives have been concluded, often referred to as a partnership flip.</p>			

Solar Incentives

Identifying and leveraging applicable incentives is an important element in whether a project will be economically viable.

Federal Incentive

- **Business Energy Investment Tax Credit:**⁹ This main federal incentive for solar power is being scaled back. For projects that begin construction before 2020, it provides a tax credit worth 30 percent of a solar project's cost. After that, the credit will be gradually reduced to 10 percent (26 percent for projects that begin in 2020, 22 percent for projects that begin in 2021, 10 percent for projects that begin after 2021). Since it is a tax credit, it can only be used by entities that pay federal income tax; municipalities can potentially access this incentive through a third-party lease.

State Incentives

- **Renewable Energy System Incentive Program:** a production-based incentive for solar and other renewable energy projects. Projects receive annual incentive payments for 8 years based on how many kilowatt-hours they generate. Projects that start operating in fiscal year 2019 receive incentive payments of \$0.04/kWh for commercial-scale systems (combined nameplate capacity greater than 12 kWdc) and \$0.14 for systems between 1 kW and 12 kW in size. For projects that start operating in fiscal years 2020 or 2021, the incentive rates drop by \$0.02/kWh each year.¹⁰ The incentive payments are capped at \$25,000 per year for commercial-scale systems and \$5,000 per year for community solar projects. There are bonus payments for projects using equipment made in Washington. The local electric utility (Avista) participates in this program. The state caps the amount of funding available to each utility for this incentive. A large new solar farm being built in Lind, Washington, may take up most or all of Avista's cap amount.¹¹ To see which utilities have funds available for this incentive, see <http://www.energy.wsu.edu/incentivedashboard/programsummary.html#creditavailable>.
- **Renewable Energy Sales and Use Tax Exemption:** Solar photovoltaic (PV) systems larger than 500 kW (or .5MW) can receive a 75 percent refund in state sales and use tax until January 2020.¹²
- **Renewable Portfolio Standard:** Washington state mandates that 9 percent of utilities' electricity production must come from renewable resources by 2016, and 15 percent by 2020.¹³ However, the standard does not include a solar carve out. A carve out would establish the percentage of electricity sales in a state that comes specifically from solar power.

Utility Incentive

- **Net metering:** Systems up to 100 kW eligible. The local electric utility (Avista) participates in this program.¹⁴ Avista's net metering agreement states that net metering is intended to offset all or part of a customer's electricity usage; therefore, the incentive would be limited by electricity usage. See Attachment B for more information.

⁹ <https://www.energy.gov/savings/business-energy-investment-tax-credit-itc>

¹⁰ <http://www.energy.wsu.edu/RenewableEnergySystemIncentiveProgram/EligibilityIncentiveRates.aspx>

¹¹ <http://www.spokesman.com/stories/2018/apr/08/81000-solar-panels-washingtons-largest-solar-farm-/>

¹² https://dor.wa.gov/sites/default/files/legacy/Docs/Pubs/SpecialNotices/2017/sn_17_renew_energy.pdf

¹³ The local electric utility (Avista) had 15.3 percent renewable energy in 2017 (<http://www.commerce.wa.gov/wp-content/uploads/2017/07/Energy-EIA-2017-Report-Summary-and-Detail-REV20170710.pdf>)

¹⁴ <https://www.myavista.com/about-us/services-and-resources/interconnection>

Conclusion

The site offers land area suitable for some recreational uses and solar development. Although the site could support athletic fields, it may be more cost-effective for the county to build athletic fields and other forms of active recreation on non-landfill properties in the surrounding area. However, the landfill could include more low impact forms of recreation such as walking trails, see Attachment C for examples of these types of recreational use at other landfills.

Due to the low rates paid to electricity producers in the area and other factors, the most suitable scale of solar development is likely to be a small-scale system sized to meet the power needs of the adjacent waste transfer station. While the site's cap does pose some limitations, these can be overcome with proper planning as has been successfully demonstrated at landfill sites across the country. At present, decreasing federal and state government incentives and a moderate solar resource may be the biggest project limitations. However, large solar projects can be feasible in eastern Washington when incentives and site conditions are right, as demonstrated by the state's largest solar farm currently being constructed in Lind, Washington. The financial landscape for solar projects will continue to evolve due to technology improvements and changes in state and federal incentives, so the feasibility of solar reuse should continue to be evaluated periodically as conditions change.

For more information about the EPA Superfund Redevelopment Initiative, please visit:

<https://www.epa.gov/superfund-redevelopment-initiative> or contact:

Kira Lynch, EPA Region 10 at phone: 206-553-2144 or email: lynch.kira@epa.gov.

Attachment A: Potential Financial Impact of Hypothetical 1 MW PV Solar Array at Colbert Landfill, Spokane County, WA

Given the wide diversity of potential entities (private land owners, local governments, federal government) that can host a PV solar project on their land, a “one-size-fits all” project structure will not fully capture the different type of project arrangements possible at the landfill. Property owners/site hosts face a range of financial, operational and strategic considerations that may favor one project structure over another.

Two potential scenarios have been envisioned to evaluate potential financial implications to the county of each option.

1. Simple Return on Investment Scenario (or Simple Payback) - potential impacts based on county ownership of a 1 MW solar system
2. Land Lease Scenario - the county receives lease fees for the land based on the acreage used for a project or the size of the PV solar system (e.g., 1 MW)

The development of a renewable energy project is a complex process reliant on changing incentives, partnership between multiple parties, suitable market conditions and other factors that must be identified and managed throughout the project. Any solar energy project at the site will depend on the ability of the county to identify and work with project partners who can deliver electricity at a competitive price and the ability of project partners to enter into a long-term purchase agreement with an electric utility or other user.

Option 1) Direct Ownership Simple Payback

Simple payback can help illustrate the importance of net upfront costs and energy purchase price on the financial outlook for a project.

For Option 1, a 1 MW project was chosen to help illustrate how project assumptions can influence payback. However, the final size of any PV solar project at the Site will be determined by available project funding and financing options, suitable acreage at the Site, and/or the amount that power can be sold to an energy utility or other end user.

Simple payback provides a rough estimate of whether an initial investment might be worthwhile. Simple payback is useful for making “ballpark” estimates, but its usefulness is limited because it does not take into account future savings or costs (such as annual O&M costs) over the expected life of a project.

$$\text{Simple Payback} = \text{System cost} / (\text{annual revenue} - \text{annual O\&M cost})$$

Scenario Assumptions:

Project System Information

Array Size: 1 MW

Module Type: Standard crystalline silicon, fixed array

Array tilt: 20°

Installed Cost: \$2 to \$3 per watt installed¹⁵

Annual Maintenance Cost: \$15 per kW

Weather Data Source: 47.85°N, 117.34°W

Estimated annual system output: 1,190,000 kWh

Acres Needed: 5-8 acres depending on technology type and panel efficiency¹⁶

Financial Incentives Considered

Federal Investment Tax Credit: Treated as one-time upfront cost reduction. Scenario analysis to estimate effect of decreasing incentive.

State Renewable Energy Cost Recovery Incentive: Annual payment based on amount of electricity produced. Scenario analysis to estimate effect of decreasing incentive.

Electricity Purchase

The scenario assumes power generated at the landfill could be sold by the county to the local utility at Avista’s Standard Power Rate of \$25.03 (2018) to \$26.57 (2022) per megawatt-hour (analyzed at \$0.026/kWh in this scenario).¹⁷

To account for factors such as periodic or annual costs, a more detailed life cycle payback approach could be used. Life cycle payback takes into account the benefits (i.e., revenues) of a solar electric

¹⁵ 2017 NREL report found costs of \$1 to \$2 per watt installed for utility-scale and commercial photovoltaic projects (<https://www.nrel.gov/news/press/2017/nrel-report-utility-scale-solar-pv-system-cost-fell-last-year.html>). This analysis assumes a cost of \$2 to \$3 per watt installed to accommodate additional costs associated with a landfill site, as well as higher costs due to tariffs imposed in 2018 on imported solar panels. Landfill solar projects tend to have slightly increased costs due to the engineering, design and construction accommodations needed to meet any limitations presented by the landfill cap.

¹⁶ <https://www.nrel.gov/docs/fy13osti/56290.pdf>

¹⁷ For rates see Sheet 62 at <https://myavista.com/about-us/our-rates-and-tariffs/washington-electric>

system over its operating lifetime and compares that to all the costs of the system over the same period of time.

Table A-1 provides a simple payback estimate for three scenarios related to direct county ownership of a system, including the ability of the county to take advantage of the 30% federal ITC through a for-profit entity.

Table A-1: Simple Payback (1 MW system)

	No Incentives	30% ITC	30% ITC + State Incentive
Initial cost (\$2.5 per watt)	\$2,500,000	\$2,500,000	\$2,500,000
Federal tax credit (30%) ^a	--	(\$750,000)	(\$750,000)
Annual O&M Cost	\$15,000	\$15,000	\$15,000
Net Upfront Cost	\$2,515,000	\$1,765,000	\$1,765,000
System Output/Payback			
System output (kWh/year) ^b	1,190,000	1,190,000	1,190,000
Potential annual sales revenue (\$0.026/kWh)	\$30,940	\$30,940	\$30,940
State incentive annual revenue (\$0.04/kWh) ^c	--	--	\$25,000
Simple Payback Period	81 Years	57 years	32 years
Notes: a) Must begin construction before 2020 for full 30% tax credit. b) Calculated using NREL's PVWatts Calculator (https://pvwatts.nrel.gov). c) System must be certified in fiscal year 2019 to receive \$0.04/kWh incentive rate. Annual incentive payment is capped at \$25,000 for commercial-scale systems.			

The long payback time estimates are driven mainly by the avoided cost payment rates offered by Avista for electricity generation. Table A-1 relies on a set of assumptions based on best currently available information. However, Table A-2 illustrates how relatively small changes in project assumptions can make a difference in estimated payback.

Table A-2: Sensitivity Analysis

	Base Case (30% ITC + \$0.04/kWh state incentive)	2021 Installation (22% ITC + \$0.02/kWh state incentive)	Payment rate of \$0.052/kWh for electricity generated	Installed cost \$2/Watt (30% ITC + \$0.04/kWh state incentive)
Simple Payback	32 years	35 years	20 years	25 years

A sensitivity analysis of the base case scenario found that installing a solar system in 2021 rather than 2018 would reduce the potential value of the federal tax credit by \$200,000 and increase

estimated payback by 3 years. If the price of electricity sold to a utility was increased to \$0.052/kWh, payback would drop to 20 years. If a solar system could be installed for \$2/watt, payback would be around 25 years.

Option 2) Land Lease Scenario

The goal of the land lease scenario is to illustrate potential revenue impacts from an alternative solar project development option - one where there is no direct ownership (i.e., by the county) of a solar energy system. Under a land lease scenario, a solar energy developer would pay to lease or rent land (base rent) at the site on which they would own and build a solar energy system.

Some solar purchase agreements and solar land leases can include a price escalator (i.e., rent paid increases over time). The estimated numbers in Table A-3 keep base rent at the same level over a 20-year time horizon.

Scenario Assumptions:

Project System Information

Array Size: 1 MW

A solar system would be developer-owned and financed

Acres Needed: 5-8 acres depending on technology and efficiency

System Ownership: Owned by third-party project developer

Land Lease Terms

The assessment surveyed both policy documents (e.g., the U.S. Bureau of Land Management's (BLM's) Solar Energy Interim Rental Policy) as well as other publicly available information to identify a range of land lease fees from planned, existing and potential solar projects. While the landfill is not BLM property, BLM rates can provide a floor for lease rates.

BLM rental rates are generally low (\$15 to \$300 per acre). However, BLM also charges a per MW capacity fee of several thousand dollars per MW in addition to the base rent. Other solar projects have lease fees ranging from \$250 per acre up to \$8,000 per acre, with an average lease rate of \$2,100 per acre.

Some developers will estimate lease fees based on the size of the solar system (MW). These fees can range from \$7,500 to \$15,000 per MW depending on the developer and local markets for the power.

The analysis assumes a lease would be fixed price and based on project footprint acreage.

Table A-3: Land Lease Revenue Estimates (1 MW solar system)

	Annual Base Rent	20-Year Estimate (constant dollars)
Acres leased	5	5
\$350/acre	\$1,750	\$35,000
\$500/acre	\$2,500	\$50,000
\$1000/acre	\$5,000	\$100,000
\$2500/acre	\$12,500	\$250,000
\$5000/acre	\$25,000	\$500,000

The value of the land lease will vary by developer, the project site and market considerations. The county should expect lease fees to be an important point of negotiation with a potential project developer under a land lease approach.

Additional Solar Information Sources

Best Practices for Siting Solar Photovoltaics on Municipal Solid Waste Landfills

<https://www.epa.gov/re-powering/best-practices-siting-solar-photovoltaics-municipal-solid-waste-landfills>

Federal Business Energy Investment Tax Credit

<https://www.energy.gov/savings/business-energy-investment-tax-credit-itc>

State Renewable Energy System Incentive Program

<http://www.energy.wsu.edu/RenewableEnergySystemIncentiveProgram/EligibilityIncentiveRates.aspx>

Re-Powering America Renewable Energy Interactive Mapping Tool

<https://www.epa.gov/re-powering/re-powering-mapper>

Solar Energy Industries Association

<http://www.seia.org>

Database of State Incentives for Renewables & Efficiency (DSIRE)

<http://www.dsireusa.org>

U.S. Department of Energy Solar Energy Technologies Office

<https://www.energy.gov/eere/solar/solar-energy-technologies-office>

NREL Solar Resource Maps

<https://www.nrel.gov/gis/solar.html>

Attachment B: Solar System to Offset Onsite Landfill Electricity Use at Colbert Landfill, Spokane County, WA

Washington currently caps net metering at systems sized 100 kW or smaller. A 300 kW system could potentially generate enough electricity to offset use from both the transfer station and the landfill office, but the County would not be eligible to undertake aggregated net metering with Avista with a system of that size.

As a result, a solar system sized at 100 kW or less may offer a more viable near-term option to both reduce on-site energy demand and maximize the financial benefit (cost savings due to net metering and production credits) for a small, direct-use system.

A typical small-scale solar energy project will vary in cost from \$3.00 to \$3.50 per installed watt depending on the complexity of the system, the type of technology, site preparation costs and local labor rates.

Table B-1 illustrates the financial implications of a hypothetical 100 kW PV solar project installed at the Site that would net meter with Avista. It provides cost estimates under two different scenarios covering a range of anticipated costs and potential savings for a 100 kW system.

Table B-1: Preliminary Solar PV Payback and Cost Estimates – 100 kW

	100 kW, no production incentive	100 kW, with production incentive	100 kW, WA made solar panels, with production incentive
Installed Cost (\$3/W) ^a	\$300,000	\$300,000	\$330,000 ¹
Yearly O&M Cost	\$2,000	\$2,000	\$2,000
Output/Estimated Payback			
Estimated Output (kWh) ^b	123,500	123,500	123,500
Annual Avoided Cost (retail purchase rate \$0.095/kWh)	\$11,700	\$11,700	\$11,700
Production Incentive Payment (year 1)	--	\$4,940	\$9,880
Simple Payback ^c	26 years	18 years	15 years
Notes: a) Assumed to be County purchased, so no federal tax credit applied (30% ITC) to installed cost. b) Estimated using PVWatts Calculator. c) Production incentive assumed to start in 2019 with a base rate of \$.04/kWh and a WA panel bonus of \$.04/kWh.			

Table B-2 illustrates the financial implications of a hypothetical 12 kW PV solar project installed at the Site that would net meter with Avista. The smaller system size (12 kW) would allow the more generous residential-scale system incentive to be utilized.

Table B-2: Preliminary Solar PV Payback and Cost Estimates – 12 kW

	12 kW, no production incentive	12 kW, with production incentive	12 kW, WA made solar panels, with production incentive
Installed Cost (\$3.50/W) ^a	\$42,000	\$42,000	\$46,000 ¹
Yearly O&M Cost	\$240	\$240	\$240
Output/Estimated Payback			
Estimated Output (kWh) ^b	15,000	15,000	15,000
Annual Avoided Cost (retail purchase rate \$0.095/kWh)	\$1,400	\$1,400	\$1,400
Production Incentive Payment (year 1) ^c	--	\$2,100	\$2,700
Simple Payback	30 years	12 years	11 years
Notes:			
a) Assumed to be County purchased, so no federal tax credit applied (30% ITC) to installed cost.			
b) Estimated using PVwatts Calculator.			
c) Production incentive assumed to start in 2019 with a base rate of \$.14/kWh and a WA panel bonus of \$.04/kWh.			

The potential financial impact of a PV system at the Colbert Landfill will depend on many factors, but in general:

- A 100 kW solar system would have an estimated yearly output of 123,500 kWh. This could offset around 30% of recent annual on-site electricity demand from the office and transfer station.
 - At a weighted-average avoided electricity cost of \$0.095 per kWh, estimated total annual savings would be nearly \$12,000. This would generate a 26-year simple payback if not participating in Washington's production incentive program
- A 12 kW system would have an estimated annual output of 15,000 kWh. This could offset approximately 4% of onsite electricity demand.
 - Because of an estimated higher installed cost, payback estimates without the production incentive are higher for a 12 kW system, approximately 30 years.
- Being able to participate in the state production incentive program would greatly increase the financial outlook of a solar project at the landfill.
 - If not using modules manufactured in Washington state, estimated- payback in 2019 would be 18 years for a 100 kW system and 12 years for a 12 kW system.
 - If using modules made in Washington, estimated payback would be 15 years for a 100 kW system and 11 years for a 12 kW system.¹⁸

¹⁸ Solar panels/invertors made in Washington state would be expected to be somewhat more expensive than Chinese panels even after accounting for price increases due to newly leveled tariffs on imported panels from China. As a result, while the incentive is more generous per kWh for panels manufactured in the state, upfront costs would also be higher.

Attachment C: Landfill Solar Project Examples

Examples of Superfund sites with capped landfills that are being reused for solar power generation are described below.

Shaffer Landfill, Billerica, Massachusetts

Shaffer Landfill is a closed landfill located on approximately 100 acres of land in Billerica, Massachusetts. A 6.0 Megawatt (MW) solar renewable energy project was built on a portion of the site. This project is the largest solar development on a Superfund landfill site in the US (as of 2014). The project had the strong support of the property owners, the Town of Billerica, the State of MA Department of Environmental Protection (DEP), U.S. EPA and National Grid (NG), the utility that services the site. A main concern was that the solar project should not affect the cap remedy implemented for the landfill. A ballasted racking approach was used in order to avoid any possibility of piercing the cap.

Success Story available here:

<https://semspub.epa.gov/work/01/75001105.pdf>



Brick Landfill, Brick Township, New Jersey

The 42-acre Brick Township Landfill in Ocean County, N.J. began operating in the 1940s and was closed in 1979. The site was placed on the EPA's Superfund National Priorities list in 1983. The cleanup work included placing a cap on the landfill to prevent rain water from seeping into the landfill and spreading contamination. While the cap was being designed, Brick Township worked to develop the plan to install solar panels on the landfill. The installation of solar panels began in June 2013 and the solar array became operational in 2014. It generates about 7,400 megawatt-hours of energy per year. A solar development company is currently operating the solar array and will continue to operate it until 2029. The township plans to take over ownership at that point. Brick Township estimates that the solar array will save the township about \$13 million through discounted energy prices over the course of 15 years.



Case Study available here: <https://semspub.epa.gov/work/02/372924.pdf>

Attachment D: Park Habitat Examples from other Superfund Sites

Communities across the country have successfully transformed contaminated sites into community recreational amenities and pollinator habitat. Examples of Superfund sites with caps that are being reused as park and open space and sites with pollinator habitat are described below.

Wildflower Meadows at the Davis Timber Company Superfund Site



This 30-acre area in Hattiesburg, Mississippi, was once a timber processing and treatment facility. In 2012, 15 acres were reseeded with native plants and wildflowers. The wildflower meadows provide several benefits:

- Support the health of pollinators, providing natural habitat where pollinators can thrive.
- Increase the land's natural beauty and appeal to visitors on the site's walking trail.
- Enhance the remedy by requiring less mowing and erosion control.



Today, the Davis Timber Company site is home to a community center, animal shelter, dog park, parking, trail connections and restored habitat for pollinators.

Case study: <https://semspub.epa.gov/src/document/04/11053844>

Pollinator Prairie at the Chemical Commodities, Inc. Superfund Site



EPA, potentially responsible parties and organizations such as the Pollinator Partnership, Wildlife Habitat Council and Monarch Joint Venture worked together at this former chemical brokerage facility in Olathe, Kansas to develop a walk-through educational natural habitat for Monarch butterflies. The site now features:

- Habitat for pollinators such as birds, bees and butterflies.
- A tagging station for Monarch butterflies.
- Informational kiosks along a walking trail.

In 2012, a ribbon-cutting ceremony opened the site as the "Pollinator Prairie".

Case study: <https://semspub.epa.gov/work/07/30244586.pdf>

Habitat and Trails at Oeser Co. Site, Bellingham, Washington



The 26-acre Oeser Company Superfund site is in a mixed-use residential and industrial area of Bellingham, Washington. Effective collaboration on cleanup work resulted in restoration of creeks and wetland habitats, as well as enhancement of recreational park trails. Migratory birds, including peregrine falcons and bald eagles, and other wildlife species make their home in the park. Enhanced bicycling and walking paths connect the site to the larger Bay-to-Baker Trail network.

Success Story:

<https://semspub.epa.gov/work/10/501000089.pdf>